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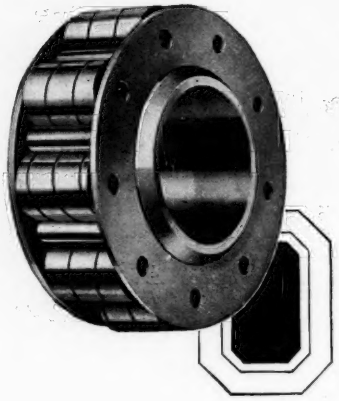

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Vol. 3 JULY, 1922 No. 7

Considerations Affecting Belt Speeds

By A. B. Welty
Mem. A.S.A.E. Mechanical Engineer, Emerson-Brantingham Company

ALTHOUGH steps have been taken by this and other engineering societies toward the standardization of tractor belt speeds it must be admitted that the ideal belt speed for any particular type and size of tractor, when the tractor alone is considered still is an open question. From the strictly manufacturing standpoint there is a tendency to propose as a standard a speed which is a compromise, or speeds which are a series of compromises, based on existing practice. From the standpoint of the strictly tractor designer there is a tendency to settle on a speed such that the designer is not likely to be embarrassed in finding room for the gears and belt pulley. The farmer himself desires a belt speed which will give satisfactory operation combined with ease in handling and belt economy as regards both investment and durability. The experimental engineer interested chiefly in belt-driven machinery shares each of the foregoing viewpoints in some measure, but particularly that of the farmer. It is from this viewpoint that the following considerations are presented.

The normal belt speed of the various well-known, widely used tractors varies from about 1900 feet per minute to more than 3900 feet per minute. As a result, manufacturers of belt-driven machinery not only must maintain a list of assorted pulley sizes for each model they manufacture, but they must in some manner find out the belt speed of the tractor or other engine which is to drive the machine before a drive pulley of proper size can be selected and installed.

For example, if a thresher designed for a cylinder speed of 1150 revolutions per minute were to be driven by a tractor having a normal belt speed of 1900 feet per minute, the drive pulley on the thresher cylinder shaft should be 6.31 inches in diameter. If for any reason it were desired to drive this same thresher by a tractor having a normal belt speed of 3900 feet per minute it would be necessary to remove the pulley from the cylinder shaft and substitute one 12.95 inches in diameter. Between these extremes comes a large variety of belt speeds calling for a large variety of pulley sizes. This is sufficient to show the imperative desirability of standardized belt speeds.

From the standpoint of strains on shafts and bearings the use of high belt speed is eminently desirable. The horsepower transmitted by a belt may be expressed fundamentally by the formula

$$\text{Horsepower} = \frac{\text{feet per minute} \times \text{effective pull in pounds}}{33000}$$

It is obvious that the effective belt pull required to transmit any given horsepower may be reduced by increasing the velocity of the belt. For example, to transmit 25 horsepower at a belt speed of 2000 feet per minute an effective belt pull of 413 pounds is required, as shown by the equation

$$25 \text{ hp.} = \frac{2000 \times 413}{33000}$$

By increasing the belt speed to 3500 feet per minute the effective belt pull would be reduced to 236 pounds, thus:

$$25 \text{ hp.} = \frac{3500 \times 236}{33000}$$

The pull on the shafts and their bearings due to effective belt pull at 2000 feet per minute would be about 75 per cent greater than at 3500 feet per minute. It is, of course, understood that the effective belt pull is the difference intention between the tight and loose sides of the belt, while the pull acting on shafts and bearings is the sum of the tensions in the tight and loose sides. However, maintenance of the necessary effective pull by a belt depends on the total friction between belt and pulley, and this in turn on the product of coefficient of friction and belt tension. Assuming the coefficient of friction to remain substantially uniform, it seems reasonable to conclude that the belt tension must be maintained at a point proportional to the maximum effective belt pull required; consequently the foregoing discussion of the effect of belt speed on effective belt pull may be considered as applying also to total belt tension.

As a natural consequence of requiring a lower effective belt pull at the higher speeds to transmit a given horsepower, it follows that narrower belts and pulleys may be used with the higher belt speed. Allowing 55 pounds effective pull per inch of belt width, at 2000 feet per minute, and adding five pounds per inch of width to the effective pull allowed at the higher speed (to offset the increased effect of centrifugal force) we find that to transmit 25 horsepower at 2000 feet per minute, a 7 ½-inch belt will be required, while at 3500 feet per minute the width will be only 3.94 inches, thus:

$\frac{413}{55}$ = 7.5 inches width of belt required at 2000 feet per minute.

$\frac{236}{55+5}$ = 3.94 inches width of belt required at 3500 feet per minute.

This means that at the higher speed a belt of any given length would be about 47.5 per cent lighter than that required for the lower speed, and the investment in belting should be in somewhat the same proportion.

Increased belt speed permits the use of larger pulleys on the driven machine, this being particularly important and desirable on threshers having cylinder speeds of 1000 revolutions or more per minute. It is well understood that small pulleys, in relation to belt thickness, are extremely undesirable from the standpoint of both power transmission and

belt life. It is a fairly well-accepted rule that satisfactory operation cannot be expected unless there are at least two inches of pulley diameter for each ply of 30-ounce duck in a canvas or rubber belt, and considerably larger pulleys are desirable if anything like maximum belt life is to be attained.

For the main belt drive between tractor and driven machine stitched canvas belting has probably been used more in the past than all other kinds of belting combined. It is, therefore, of importance that canvas belting sometimes fails by cracking transversely, and it seems reasonable to infer that this cracking results from repeated flexing under tension. By reducing the shortness of flexing, with the use of the higher belt speeds and larger pulleys we may expect to prolong the life of all kinds of belting very materially.

There is a fairly common belief among operators of farm machinery that an engine will develop more power with a long belt than with a short one. This impression is, of course, erroneous, but in handling the varying loads and momentary overloads such as are encountered in threshing a given engine often will perform more creditably with a long belt due to the greater amount of energy stored in it by virtue of its velocity. Insofar as the performance of the engine is concerned the entire weight of the belt may be considered as flywheel weight acting at the rim of the belt pulley.

However, the purpose of introducing this thought is not to advocate the use of long belts, but rather to call attention to the beneficial effect of the main belt as a reservoir of power, and to point out that the amount of energy stored in a moving belt increases, not in direct proportion to its speed, but in proportion to the square of the speed, according to the well-known formula for kinetic energy.

$$KE = \tfrac{1}{2}\, mv^2$$

Important as is the sum total of the advantages set forth above, high belt speeds have their disadvantages. One of these is the increased diameter and weight of pulleys. Within the limits likely to be encountered in practice the matter of weight is of such small consequence that it can be dismissed without further consideration. The larger diameter of the belt pulley often becomes a matter of serious concern, as many tractor designers will testify. Taking a farsighted view of the matter it would seem better to adopt a reasonably high belt speed and build every tractor in conformity with it rather than to design the tractor first and put on a pulley of such size as there might happen to be room for, allowing the belt speed to be what it may.

On the usual types of farm machinery, such as grain threshers, clover hullers, silage cutters, feed grinders, corn shellers, saw mills, wood saws, etc., there seldom is any lack of room for a pulley of such diameter as to permit belt speeds as high as have been recommended for agricultural practice. Occasionally a serious exception to this statement occurs, such as the adaptation of grain threshers for threshing peas and beans. For making this adaptation (and it is one which may become desirable with almost any make and size of grain thresher) the speed of the threshing cylinder must be reduced about half, calling for the installation of pulleys twice the normal diameter.

In conclusion, the reader's attention is called to the statement appearing on page 1144 of the ninth edition of Kent's Mechanical Engineer's Handbook which reads: "The belt speed for maximum economy should be from 4000 to 4500 feet per minute."

The Ahart Method of Tractor Plowing

By **J. Leo Ahart**

Mem. A.S.A.E. "Boni Agri" Farms, Dow City, Iowa

ANY farmer who has used horses for plowing, following the custom of beginning at the outside of the field and going around it continually until finished, knows the following facts about this method of plowing:

1. It is the quickest way to plow any field completely.
2. One will always finish in the center of the field regardless of its size or shape.
3. There will be no odds and ends left to plow afterwards.
4. It results in the minimum number of deadfurrows and backfurrows.
5. It requires no setting of stakes or measuring off of distances.
6. Its main objection lies in the fact that the horses tramp the life out of the freshly turned soil in the turn rows leading away from each corner.

The same man will recognize as the chief limitation of the modern tractor plowing outfit its inability to turn an inside corner successfully with the plow in the ground after the first round is made. He will say that tractor plowing would be ideal if this problem were solved, if one could plow around a field with a tractor and at the same time eliminate the one objection he has to this method of horse plowing. In some communities the horse farmers consider the packing of the soil in the turn rows a serious objection and for this reason they plow their fields by marking out lands and plowing each land separately, even though they may lose the many advantages of plowing around and around the field.

The power farmer has generally used the same method of plowing out lands with his tractor from the start because he has known no other way to meet the difficulty at the inside corners. Another reason why tractor plowing is almost always done in this manner at the present time is that the thousands of tractor interested farmers who have attended the many tractor plowing demonstrations during recent years have always observed that the demonstration plowing was done in lands. It was natural for one to think that the tractor and plow manufacturers would use the best available method in order to show off their products to best advantage. Consequently, the method was adopted wherever tractors are used. However, it was the only method that could be used at a demonstration and give each exhibitor an equal chance in the same field. It should not be taken for granted that it is the best method of plowing for the individual to use generally. Any farmer may well ask himself the question: Was the demonstration field really completed and would I be willing to accept it, taken as a whole, as a good job of plowing?

Any power farmer who has done any plowing knows the faults and limitations of this method. He knows the cost of the time that is lost in traveling with the plow out of the ground a number of times over the same ground at the ends. It can easily amount to five or ten per cent of the total time spent in plowing a regular shaped field. He knows the difficulties which are sure to follow if the lands are not staked out accurately, one difficulty being the inevitable floundering with the outfit on the plowed ground to finish a point. It is such things as this which take a good share of tractor enthusiasm out of the owner and which his neighbor is certain to observe.

(Left) Mr. Ahart plowing with his three-plow outfit at Boni Agri Farms. Note the turn strip, retouched white, in the distant corner at the right. (Right) A small field of a few acres which was plowed according to the Ahart method. There were no backfurrows in this field, and the only deadfurrow can be readily seen

Perhaps he has given up trying to do a good job of plowing with the tractor in his irregular shaped fields because if he has to finish a number of scattered patches with horses why not plow the whole field with horses? He will do it sooner or later if he does not change his method of tractor plowing. He knows that plowing out the headlands either with the tractor or horses after the tractor has run over it many times is not a pleasant or satisfactory task.

If we accept the method of plowing out lands as the best available knowing its many faults which we will have to admit sooner or later, we would not be keeping pace in this important regard with the rapid advance which has characterized the tractor industry. The problem has been a difficult one for the manufacturer. While he has been forced to recognize in the matter a large part of the sales resistance he has had to meet, and is meeting, the policy has seemed to be that the less said about it the better. The writer has at hand a service manual which is being distributed by a large manufacturer. In it are incorporated brief directions for plowing a regular shape of field in three different ways and for plowing a triangular field. In three of the four cases dealt with the operator is made to believe that he can expect to finish the field with horses. No attempt is made to show how a field with curved sides or otherwise irregular in shape can best be plowed; and neither is an attempt made to meet adverse topographical conditions.

There is obviously great need for research in the matter of plowing methods to meet adverse conditions. The ability of a machine to accomplish satisfactory work in every particular will determine its future demand and plowing is the biggest tractor job.

Through experience as a farmer in a hilly section of the country, the writer has met about every problem and condition which can confront a man while plowing with a tractor. He realized a few years back that if the power farmer was to have a method of tractor plowing which he could use economically in all his fields, regardless of size, shape, and topography, something quite different from anything in general use would have to be devised. To be definite and usable any new plan would have to be based on true engineering principles and so simple that the average operator could appreciate its advantages after a single trial.

The best solution to the problem seemed to be a system of plowing around the field and providing for the outfit to make the turns successfully. This plan obviously would take care of all shapes of fields and make it possible to plow hills by themselves to prevent throwing the furrows too much uphill, the remainder of the field being plowed separately. Strips of land of the proper width definitely laid out for the turning to be done on could be left at each corner and these could be plowed afterward. With this idea as a foundation, the development of the method began three years ago. At first no attempt was made to mark off the turn strips and the corner was allowed to take care of itself. The result was a turn strip of uneven width and ragged sides and the finished job was not satisfactory. When plowing under sweet clover for corn, for instance, the poor job of plowing at the corners made necessary considerable extra work with the disk before the field was ready for the planter and to prevent the clover from growing. It is very unsatisfactory to plow over ground which has once been plowed, especially in sod.

It was found that by locating the turn strip accurately on the bisecting line of the corner angle and marking it off with all the bottoms of the plow set to plow three or four inches deep much time was saved and the finished result was a complete and satisfactory job. By throwing the mark furrows away from the center of the turn strip, no difficulty will be had with the plow on entering and leaving the soil and no backfurrow will result when the turn strip is plowed out later. The rule for neat work is to pull the trip as the point of the first bottom reaches the mark furrow in every case. The plow will then enter and leave the ground all within the width of the mark furrow if the vertical hitch is correct and the axle hangers properly lubricated.

At first, the turn strips were located by taking time before the field was plowed to measure carefully the angles at the corners and set a stake well out into the field to guide the operator in laying out the mark furrows. It was not very accurate in hilly land on account of varying length of pace in going up and down hill, for the method to function properly requires that the turn strip be exactly on the bisector, and trouble was frequently encountered when the distances were paced off. Besides, it required considerable time to stake out a field, especially if it happened to be irregular in shape.

Experience as an officer in field artillery led to the adoption of an angular measuring instrument similar to that used in that branch of the service. The patented instrument designed especially for use in plowing has been called the anglemeter. It is very simple and can be carried easily in the vest pocket. It locates without having to get off the tractor the bisector of any corner angle in a few seconds. While its accuracy might be doubted at first blush, there is ample provision for the beginner to check his measurement and good results are assured. The instrument itself consists merely of a scale with a string attached so that a constant radius may be maintained between the eye and the scale; with the free end of the cord held between the teeth or under the chin, and the scale held perpendicularly to the cord, the horizon between the two sides of the field leading away from the corner can be

measured quickly in the same manner as a yardstick is used to find the length of a log. The bisector is then readily located by simply scaling the half angle. Proper divisions on the scale make this calculation very simple. Topographical conditions do not affect the use of the instrument.

In practice the method operates, stated very briefly, as follows: The operator enters any field with his outfit and without any preliminaries proceeds to plow. If the field is fenced he plows one round before laying out the turn strips because this is the best way to plow the ground which is farthest into the corners. As he comes up to the first corner he stops the outfit, locates the bisector, and plows the mark strips for a distance of a few hundred feet away from the corner. It is not best to lay out the turn strip the full length because it may be desirable to correct it a little later on and it can be easily prolonged if necessary. At the end of the second round the field is laid out.

It will be observed that the turning is done on different ground each time, this eliminating the packing of the soil. Thus one of the main objections a farmer usually raises against tractor plowing is removed. The turns are made very quickly and the time lost with the plow out of the ground is very small. During a demonstration before representatives of a large tractor manufacturer recently, which was given by the writer at the request of this concern that the merits of the method might be studied at first hand, and in which a small two-bottom outfit was used, the time required at the turns averaged nine seconds. For this demonstration a very irregular and hilly field about six acres in area was chosen. It was straight only on one side and was a field that would ordinarily be considered impractical to plow with a tractor. The plowing began at nine o'clock and was easily finished at six o'clock, an hour being taken out for lunch. It was the first time the operator had used the method. A number of horse farmers present could find no fault with the work, either while it was being accomplished or with the finished job. The statement was made that it was the first demonstration field observed which was really finished and ready for subsequent seedbed operations. In this demonstration no attempt was made at speed. It was made primarily that the workings of the method might be studied.

Here at "Boni Agri" where we have fields of every shape, size, and topography that will be found on the average farm in the hill section of western Iowa, horses have never followed the tractor to finish any field. Extra pains were not taken that this statement might be made truthfully. It is the natural consequence of the method of plowing used. We have developed and standardized also a method for crossing ditches without stalling the outfit and a method of getting around straw piles and similar obstructions neatly, both of which have been found very valuable in completing a field in good time and introducing system into the work.

It is one thing to turn a large acreage during the first few days with a tractor plowing outfit in a large, level, and regular shaped field, but to secure a high average daily performance for the completed job with the same outfit in a hilly and irregular field is quite another matter. The method of plowing which we have developed, and which has been called the Ahart method for want of a better name, is designed to meet successfully the obstacles which commonly interfere with continuous operation until completion in the fields of the average corn-belt farm, and to remove the objections which the dyed-in-the-wool horse farmer has had good reason to raise against tractor plowing. With us the method has meant the difference between profit and loss in our tractor plowing operations. It is a method of universal application, except where many deadfurrows are necessary on account of poor drainage: it is easy on the operator and machinery.

The method is fast replacing other methods in this locality, and where it is once tried plowing in lands seems to be forgotten; at least, it has been our observation that plowing in lands has never been resorted to after once using the new method. Dealers have been quick to see the possibilities of the method in lessening sales resistance and are doing their demonstrating with it with success. It is also a splendid method to use with a high lift gang plow and horses as some farmers are finding for with it no turning is done on the plowed ground and the minimum of time is lost in turning.

EDITOR'S NOTE: Unquestionably Mr. Ahart has discovered the one best method of plowing with a tractor. It will be noted in the foregoing that the "anglemeter" used with this method has been patented. The anglemeter and the manual describing the Ahart method in detail may be purchased from Mr. Ahart at a nominal price.

Horsepower Requirements of Silage Cutters

EDITOR AGRICULTURAL ENGINEERING:

HAVE you any data on file regarding the horsepower required to drive a silage cutter equipped with blower and without? Also is there any recorded data showing the power required with straight knives or curved knives?

J. MACGREGOR SMITH
Professor of Agricultural Engineering,
University of Alberta, Canada

Until the last two years we have been manufacturing the cylinder type of silo fillers only. Consequently our tests have been more thorough on this type of machine, although we have done considerable testing during that time on flywheel cutters. You understand it is practically impossible to estimate the exact power requirements for cutting only and for elevating only with the flywheel type of cutter.

As to the power required to operate silage cutters with curved or straight knives, we have no such data inasmuch as all our tests have been made with curved knives. My personal opinion on this is that it requires a certain amount of power to cut regardless of whether it is being done with curved or straight knives, although a curved knife naturally would require a longer time to make its cut while it is being drawn past a shear plate. It requires a somewhat longer shear plate on a straight knife than on a curved knife although the power requirements must be exactly the same, even though a curved knife requires more time for cutting.

The power requirements on a 30-foot silo with a cylinder cutter and conditions favorable are very nearly one horsepower per ton. We have also made tests on 40-foot silos and we find if conditions are favorable that this can be done with 1.2 to 1.3 horsepower per ton. If we assume that it requires ½ horsepower per ton to do the cutting, then on a 40-foot silo it would require 40 per cent of the power for cutting, which amounts to .52 horsepower, and 60 per cent for elevating, which is .78 horsepower, or a total of 1.3 horsepower, which I believe is very near the average horsepower requirements. Our experience has been that with flywheel cutters on 40-foot silos it would require from 1.8 to 1.9 horsepower per ton. In making these tests we have always

RESULTS OF TESTS FOR CAPACITY AND HORSEPOWER REQUIREMENTS OF SILAGE CUTTERS MADE BY THE UNIVERSITY OF WISCONSIN, SEPTEMBER 1921

(Height of silo 40 feet)

Make	Type	Length of cut —inches	Hp. hrs. per ton	Tons per hour	Average hp. required
A 17" knife 15" throat	Cylinder	21/40"	1.27	14.28	18.14
B 15" knife 13" throat	Flywheel	⅜"	2.02	9.03	18.24
C 16" throat	Flywheel	½"	2.20	14.28	31.42
D 15" throat	Flywheel	⅜"	2.23	12.36	27.56

been very careful to have the power and cutter in the right proportion, that is, if a large sized cutter were operated with a limited power it naturally would require more horsepower per ton due to the fact that the cutter could not be fed to its capacity. All these tests were made with one-half-inch cut.

On the accompanying table giving a report on tests made at the University of Wisconsin it will be noted that two of the machines were cutting in three-eighths-inch lengths, which, of course, requires a little more power, for which an allowance should be made. I believe that if these cutters were cutting one-half-inch lengths the amount of power consumed would be approximately 1.9 horsepower per ton. Referring to the flywheel cutter with 15-inch knife and 13-inch throat for example, this required 2 horsepower per ton, and if we allow one-third of the power required to cut as a saving by cutting one-half-inch lengths, this would bring the power consumed approximately to 1.9 horsepower.

HENRY M. GEHL
Gehl Brothers Manufacturing Company

Tile Size Standardization*

By James A. King
Mem. A.S.A.E. Director of Extension, Mason City Brick and Tile Co.

and Ralph L. Patty
Mem. A.S.A.E. Extension Specialist in Agricultural Engineering, South Dakota State College

IN THE discussion of tile size standards, the practical features of factory economy must be considered as well as the practice and theory of design. The statements, therefore, of men engaged in the production of tile have been made a part of this report.

One tile manufacturer having a widely distributed product writes as follows:

"We very much question whether or not it is advisable to make or use a 4-inch drain tile for the reason that it costs the same to lay a 4-inch that it does a 5-inch, and as you no doubt know, the carrying capacity of the 5-inch is nearly twice as great as the 4-inch. Under flood conditions we are sure that the extra capacity of the 5-inch is well worth while. It is a fact that a great many of our best farmers and engineers in Iowa are going to nothing smaller than a 6-inch for branches. We believe, however, that in some cases they are wrong and that for latterals of short length in many cases the 5-inch tile is large enough. * * * *

"We feel very sure that there is no occasion at all for 9-inch but we do believe it would be difficult at times to get along without a 15-inch. It would be better to drop the 14-inch than the 15-inch, and it would not be difficult to get along without the 16-inch."

Another has contributed the following:

"We think that the sizes of drain tile are pretty well standardized among the clay-tile manufacturers. We, after serious thought, cannot really make any further recommendations regarding sizes. We think they are about as practical as possible. Of course, 4-inch tile are too small for any farm drainage work, and it is quite universally thought so, but we will practically have to continue manufacturing this particular size because they come in very handy for such work as cellar drains, etc., in connection with general building contracting work. There surely is no real necessity for one-half-inch sizes; we think they are made more for a talking point by manufacturing concerns that make them than because of real necessity of them. The 9-inch size is absolutely necessary; they are made quite a bit cheaper than a 10 or 12-inch because they are made by a different process, as a rule, and can be manufactured cheaper. There are numerous cases where an 8-inch is too small and a 9-inch would suffice very nicely. There would be no advantage in doing away with this size as far as manufacturing cost is concerned either as to handling or distributing."

In the accompanying tabulation of relative costs and capacities of drain tile, the retail carlot price f. o. b. factory have been used as a basis of costs. Sizes from 4-inch to 12-inch, inclusive, represent the product of a representative clay tile factory; while sizes from 14 to 72 inches inclusive represent the product of a representative concrete tile factory. The bulk of the drain tile of the country is now made by clay and cement companies who follow quite uniformly the size variations shown in this table.

It will be noted that their sizes increase in units of two inches up to forty-eight, and beyond this point increase in units of six inches. For years the sewer pipe people have been accustomed to increase sizes of sewer pipe in units of three inches; and yet most of them increase the sizes of their drain tile products in units of two inches above the sixteen-inch size.

The percentage figures represent the per cent which the amount of increase (either theoretical capacity or price) is of the smaller sized unit, not of the larger. Opposite the 15-inch is found capacity increase of 14.795 per cent and price increase of 25 per cent. This means that the amount of difference in theoretical capacity between the 14-inch and the 15-inch is 14.795 per cent of the capacity of the 14-inch, etc., while the percentage figures opposite the 12 to 15 shows the relation between the 12 and the 15.

The capacity increase for all sizes from 12 inches and up is computed for increases of one, two, and three inches; and above 48 also for increases of six inches.

The percentage increases in capacity and cost are reasonably correlative. When there is a sudden increase in cost percentage as compared to capacity percentage, it is because of a variation at that point in web thickness or length, or some such factor which enlarges the cost increase for that size.

In the making of clay tile, the 11, 13, and 17 do not nest well with other sizes, and so would have a higher relative cost. Engineers throughout the Mississippi Valley already tend to increase in two-inch units above the six-inch size. Already sales of 7-inch is materially less than of either the 6 or 8-inch, while the sale of 9-inch is very materially less than that of either 8 or 10-inch. The relative sale of 15-inch also seems to be on the decrease.

In general the great basic error made in the design of drainage systems is to make the mains too small. The desire for economy in the cost of construction seems to overrule the question of ample margin of safety. Engineers are growing away from this error. But boards of supervisors and private owners will persist often in sacrificing capacity and safety for economy. There even seems to be an increased

*Paper presented at the fifteenth anual meeting of the American Society of Agricultural Engineers, Chicago, December, 1921.

Relative Costs and Capacities of Drain Tile

Diameter —inches	Price per thousand feet f.o.b. factory[1]	% increased capacity over previous size	% increased cost over previous size
4	28.00		
5	37.00	56.250	32.143
6	46.00	44.000	24.324
7	58.00	36.111	26.087
8	71.75	30.612	23.708
9	104.00	26.562	31.010
10	131.00	23.456	25.962
11		21.000	
12	170.00	19.008	
10 to 12		44.000	29.771
13		17.408	
14	224.00	15.976	
12 to 14		36.111	31.765
15	280.00	14.795	25.000
12 to 15		56.250	64.706
16	320.00	13.777	14.285
14 to 16		30.612	42.947
17		12.891	
18	400.00	12.111	
16 to 18		26.562	25.000
15 to 18		44.000	42.857
19		11.420	
20	480.00	10.803	
18 to 20		23.456	20.000
21		10.250	
18 to 21		36.111	
22	560.00	9.751	
20 to 22		21.000	16.666
23		9.298	
24	640.00	8.885	
22 to 24		19.008	14.286
21 to 24		30.612	
25		8.507	
26	920.00	8.160	
24 to 26		17.402	43.744
27		7.840	
24 to 27		26.562	
28	1080.00	7.545	
26 to 28		15.967	17.391
29		7.270	
30	1200.00	7.015	
28 to 30		14.795	11.111
27 to 30		23.456	
31		6.777	
32	1320.00	6.556	
30 to 32		13.777	10.000
33		6.348	
30 to 33		21.000	
34	1560.00	6.152	
32 to 34		12.891	18.181
35		5.977	
36	1760.00	5.796	
34 to 36		12.111	12.821
33 to 36		19.008	
37		5.710	
38	2000.00	5.478	
36 to 38		11.420	13.625
39		5.332	
36 to 39		17.402	
40	2160.00	5.194	
38 to 40		10.803	8.000
41		5.063	
42	2480.00	4.938	
40 to 42		10.250	14.815
39 to 42		15.976	
43		4.819	
44	2680.00	4.705	
42 to 44		9.751	8.065
45		4.597	
42 to 45		14.795	
46	3000.00	4.494	
44 to 46		9.298	11.940
47		4.348	
48	3200.00	4.301	
46 to 48		8.885	6.666
45 to 48		13.077	
49		4.211	
50		4.123	
48 to 50		8.507	
51		4.040	
48 to 51		12.886	
52		3.960	
50 to 52		8.160	
53		3.882	
54	4000.00	3.809	
52 to 54		7.840	
51 to 54		12.109	
48 to 54		26.562	25.000
55		3.738	
56		3.338	
54 to 56		7.544	
57		3.603	
54 to 57		11.419	
58		3.539	
56 to 58		7.270	
59		3.478	
60	4800.00	3.418	
58 to 60		7.015	
57 to 60		10.803	
54 to 60		23.456	20.000
61		3.361	
62		3.306	
60 to 62		6.777	
63		3.252	
60 to 63		10.250	
64		3.199	
62 to 64		6.555	
65		3.149	
66	5840.00	3.101	
64 to 66		6.350	
63 to 66		9.751	
60 to 66		21.000	21.666
67		3.053	
68		3.008	
66 to 68		6.152	
69		2.963	
66 to 69		9.297	
70		2.919	
68 to 70		5.969	
71		2.877	
72	7040.00	2.836	
70 to 72		5.796	
69 to 72		8.884	
66 to 72		19.008	20.548

[1]Prices for diameters from 4 inches to 12 inches inclusive are Mason City Brick and Tile Company, f.o.b. factory prices for clay tile. Prices for diameters above 12 inches are Minnesota Pipe and Tile Company, f.o.b. factory prices for concrete tile.

tendency this year to use 4-inch instead of 5-inch because of saving in cost. If these intermediate sizes were available they would be an additional temptation to economize in first cost at the expense of safety or capacity under emergency. Any justified savings thus made would be far more than offset by unjustified and unwarranted restrictions of capacity on other jobs.

Spread the saving in first cost over the total acreage served by a ditch and it will sink into insignificance as compared to the acre damage done when the reduction proves to be poor engineering. The saving is made only once, while the loss is repeated each time there is a wet spell in which the ditch proves inadequate to the demands made on it.

When one of these intermediate sizes could be used without sacrificing capacity of ditch this object may be accomplished by using a smaller supplementary main for that tract nearest the outlet. Thus a 6-inch would make more than a half break in capacity between a 16-inch and an 18-inch. The difference in cost per 1000 feet between the 16 and the 18-inch is $80; and this will be considerably more by the time they are delivered on the ditch because of greater freight and haulage costs. The cost of the 6-inch is $46—only slightly over half the f. o. b. factory cost difference between 16 and 18-inch. Thus provision is made for this intermediate increase in main capacity at an intermediate cost. And yet it is not available in such form as to be so tempting to the penurious-minded individual.

Dependable figures for costs for maintaining dies and carrying stocks in the yards are not available. The labor and expense of keeping costs on these items is out of proportion to the benefit the management would receive from keeping them.

The only possible place where the use of 4-inch tile can be justified is in hilly lands where steep grades are available. Even there the wisdom of their use might be questioned.

From 16-inch up the percentage increase in theoretical capacity for each inch increase is from 12.9 per cent down. In these sizes it is easily conceivable that variations in actual net carrying capacity of the finished ditch, due to accidents of manufacture or of construction would largely nullify this theoretical difference. Thus the wisdom of increasing diameters by less than 2-inch units seems questionable. When the 24-inch and larger sizes are reached it is indefensible. While no definite recommendation can yet be made it seems that the 4, 9, and 15-inch sizes could be dispensed with, although the 15-inch size seems to be more thoroughly intrenched in usage. On the other hand, the trend seems to be away from it to at least a noticeable degree and the danger of damage from false economy in its use is greater than with the smaller sizes.

Somewhere in the region of 30-inch it would seem logical to change to a unit increase of 3 inches instead of 4 inches. Then again in the vicinity of 40-inch change to a unit increase of 4 inches. Thorough consideration, however, has not been given to just what the intervals should be for the different sizes, therefore, no recommendation can be given at this time.

DISCUSSION OF TILE SIZE STANDARDS

By David Weeks
Mem. A.S.A.E. Drainage Engineer, Dakota Engineering Company

DRAIN tile diameters should be adjusted so the likelihood of flooding or excessive pressure at any point due to lessened capacity will be reduced to a minimum. Two factors must be considered, therefore, in selecting diameter intervals from a standpoint of design. First, the relation should be uniform between the drainage coefficient which might prevail, due to the use of the next commercial size larger than that required, and that coefficient which is used in design. The other factor to be considered is to have this interval as small as is in keeping with economic practice and still keep the relation between drainage coefficients uniform. In order that the relation between the possible maximum coefficient and the designing coefficient may remain constant the following relation would exist between ΔQ, the increment in discharge between successive tile diameters and the discharge.

(1) $\Delta Q = K_1 Q$

To find what ratio should exist between the increment in diameter, ΔD, and diameter, D, it is possible to find the rate of change in the discharge with respect to diameter and to express Q in terms of the diameter. From the Woodward-Yarnell formula for flow in drain tile the following relation will be found to exist between discharge, Q, and diameter in inches, D, and slope, S.

(2) $Q = K_2 D^{8/3} D^{1/2}$

(3) $$\frac{\Delta Q}{\Delta D} = K_3 S^{1/2} D^{5/3}$$

(4) $$\Delta = \frac{\Delta Q}{\Delta D} \Delta D$$

Substituting in equation (1)

(5) $\Delta D \cdot K_3 S^{1/2} D^{5/3} = K_2 D^{8/3} S^{1/2}$

or (6) $\Delta D = KD$

In other words, the interval in inches between tile diameters should vary in inches in a direct proportion with the diameter.

If one inch is the proper interval in diameter for a 5-inch tile then proper intervals would be two inches for a 10-inch tile, three inches for a 15-inch tile, four inches for a 20-inch tile, six inches for a 30-inch tile, eight inches for a 40-inch tile, and twelve inches for a 60-inch tile.

Other considerations, however, may make it wise to maintain a smaller interval between the larger sizes. It must be remembered that the larger tile is serving a much larger area, and therefore the greater cost of any excess in size is spread over a much larger area. If an analysis is made upon the basis of cost of the possible excess due to selecting the next larger commercial size, it will be found that a still larger interval would be consistent with economic practice. Cost per acre for the excess in size over that required by design is not the controlling factor.

The effect upon the possible range in drainage coefficient, if the above intervals were adopted, can be seen by making a few computations. A 10-inch tile with 0.5 as a minimum coefficient will drain 40 acres, if the Woodward-Yarnell formula is used. If the area is slightly over this, the 12-inch would be used with a resulting coefficient of 0.81 or an increase of 62 per cent. Likewise the interval between the 20 and 24-inch gives an increase of 62 per cent in the coefficient, and the interval between the 30 and 36-inch gives an increase of 62 per cent in the coefficient. It seems that 62 per cent is altogether too much and might lead to undesirable results. A much more reasonable range of intervals would result from assuming that the one-inch interval is proper for the 8-inch size. If such is the case, the interval would be less than 2 inches until the 16-inch size is reached and less than 3 inches until the 24-inch size is reached, etc. Such a scale of intervals would result in a maximum possible difference in drainage coefficient, at a point of change in tile size or grade of 37 per cent; even this seems somewhat high. Such a scale, however, would make it possible to adopt the same standards as have been established for sewer pipe without any serious changes.

Sewer pipe was standardized by the War Industries Board during the war to include the following sizes: 4, 6, 8, 10, 12, 15, 18, 20, 21, 24, 27, 30, 33, and 36-inch. The 20-inch was left in because of its popularity. These standards could be adopted for drain tile without seriously upsetting the above theory. It is believed, however, that one-inch intervals should be retained at least up to a 10-inch tile. It seems that above 36-inch the intervals could be 4 inches without any undesirable results, and above 48 inches a 6-inch interval should not be inconsistent with the above analysis.

Many engineers lose sight of the fact that usually grades and tile sizes can be so adjusted that the minimum economical coefficient can be used almost uniformly throughout a project where the grades are not too flat.

Broader Scope for Engineering*

THE broadening scope of engineering training and practice is a recognition of the engineering type of mind. The administrative side of industry has brought the engineer face to face with the greatest problem of all ages, the status of the human factor in industry. While formerly "engineering" was used to denote activities in design, construction and operation of machinery, highways, bridges, etc., today the industrial engineer, financial engineer and other types of engineer are being trained, indicating the passing of empiric and speculative methods of attacking the problems of industry and the growing importance of the scientific method in its broad application to human welfare.

The demand for further extension of the curriculum of engineering schools to include instruction in human relations is logical and deserves very careful consideration, but this demand is frequently made for the purpose of having men prepared to suit some peculiar industry or the opinion of some particular group of people. As a consequence there are appearing some narrow and highly specialized courses of instruction to meet these demands. While there are some places where special courses of the kind mentioned are justifiable, these special courses do not solve the general problem and there are certain grave objections to these highly specialized courses so strongly demanded by industrial managers.

*From an address by Dexter S. Kimball, dean of the college of Engineering, Cornell University, before the Academy of Political Science.

Tractor Motor Lubrication and Kerosene Fuel

EFFORTS have been made by F. W. Duffee of the department of agricultural engineering, University of Wisconsin, using one brand of lubricating oil to determine the lasting qualities of the oil when burning kerosene. This oil had an initial viscosity of 540 seconds at 100 degrees Fahrenheit as measured, and at the end of fifteen hours running the viscosity had dropped to an average of 200 seconds for two tests, and the oil had to be changed. The greatest drop in viscosity occurred during the first two and one-half hours.

It was found important to warm up the motor well before shifting from gasoline to kerosene. By burning the high-test gasoline for half an hour at the beginning no material advantage was obtained over merely warming up with common low-test gasoline. Different motors will, of course, obtain different results; in some cases oil will last twice as long, the principal reasons being the amount of oil in the crankcase and the efficiency of the carburetor.

Agricultural Engineering Development

A Review of the Activities and Recent Progress in the Field of Agricultural Engineering Investigation, Experimentation and Research

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VISCOSITY AND FRICTION, W. H. Herschel [*Journal of the Society of Automotive Engineers*, New York, 10 (1922), No. 1, pp. 31-41, figs. 2.] The author divides the study of lubrication into different regimes in which different properties of the lubricant have the controlling influence, and discusses at length viscosity effect in the complete-film-lubrication regime. Comment is made on the properties of lubricants, units for viscosity measurement, and absolute viscosity relation to the readings of instruments ordinarily used. Mathematical analysis are presented with reference to data given in tabular and chart form.

The estimation of viscosity at one temperature from the observed viscosity at another temperature is treated in a somewhat similar manner, including a discussion on complete film lubrication, general friction, and viscosity.

Consideration is given to the transition point, the relation between the different factors at the transition point and incomplete film lubrication, and the oiliness of lubricating oils. A lengthy discussion is also given of the differences in oiliness of different lubricants as indicated by laboratory and service tests.

Ten specific desirable features of oil friction testing machines are enumerated as (1) means for attaining as high a pressure as possible without danger of an inconveniently rapid change in area of rubbing surface due to wear, (2) a drive arrangement to permit of a sufficiently low speed, (3) a sensitive and easily calibrated method of measuring friction, (4) means for supplying the lubricant in unlimited or in definitely measured quantities together with a device for spreading it uniformly over the rubbing surfaces, (5) means for measuring the pressure in the oil film, (6) means for measuring the temperature of the oil film, (7) means for controlling the temperature of the bearing, (8) means for observing the point of seizure accurately and to prevent roughening of bearing and journal when seizure occurs, (9) means for measuring and adjusting the film thickness, and (10) means for changing the rubbing surfaces readily to permit the study of wear, bearing metals, and efficiency of oil grooves, and more especially for maintaining the rubbing surfaces at a constant smoothness when testing lubricants.

It is concluded that "in comparing viscosity and friction it is necessary to use a unit of absolute viscosity, preferably poises can be calculated from times of flow in seconds by suitable equations that are given for the viscosimeters most frequently used. In estimating the change of viscosity with the temperature, it is convenient to make use of the observed fact that, with certain restrictions, the logarithmic viscosity-temperature graphs are straight lines which meet at a point. Friction tests with complete film lubrication can give no information in regard to the quality of a lubricant, and viscosity is measured more readily with a viscosimeter.

"The only use of a friction-testing machine for determining quality of a lubricant is in measuring oiliness, and this must be done at high pressures, low speeds or other conditions which cause incomplete film lubrication. It can be assumed that the pressure must be over 800 pounds per square inch (56.2 kilogram per square centimeter) or the speed less than 40 feet per minute (0.2 meters per second). Bearing metals also should be tested with incomplete film lubrication. It is impracticable to keep a constant smoothness of rubbing surfaces with a journal bearing, so that changes in friction, commonly supposed to be due to changes in quality of lubricant, are generally due to changes in smoothness.

"Service tests are even more untrustworthy than friction tests, because there are a multitude of bearings whose temperature can not be controlled or estimated readily. The best solution of the difficulty appears to be the use of a disk machine. The disk could be kept of constant smoothness by removing an interchangeable veneer and subjecting it to a standardized polishing process after the test of each oil, if necessary. A journal could not be kept polished in this way because the radius of curvature, and consequently the film thickness, would be changed."

A NEW HYDRAULIC APPARATUS FOR MEASURING TRACTIVE EFFORT, M. W. Polak [Mededeelingen van de Landbouwhoogeschool en van de daaraan Verbonden Instituten (Wageningen), 21(1921), No. 3, pp. 48, pls. 5, fig. 1.] This report deals with traction dynamometers in general and hydraulic and spring types especially. Comparative experiments with different types indicated that in a comparison of the reliability of similar dynamometers, experiments should be made with the two instruments connected in series. These should yield the same results in several trials, and any marked variation in results is taken to indicate the unsuitability of the apparatus.

Experiments with spring dynamometers showed that they do not indicate a lower tractive effort than the actual as is generally supposed. A new hydraulic dynamometer is described, the principle of which is based on the relation between the pressure upon a liquid and the quantity of it which will flow out of an opening of a given size within a given time. The instrument consists of a cylinder and piston, with a 10-centimeter stroke and diameter, a high-pressure rubber tube, and a measuring apparatus. When in operation, water is permitted to flow under pressure from a small opening into a glass measuring tube. The quantity of water flowing into the tube in a given time gives a direct measure of the average tractive effort, and duration of time is measured precisely as the opening and closing of the tap is controlled automatically by a chronometer.

Comparative experiments with hydraulic and spring dynamometers are reported, leading to the conclusion that there is no special traction dynamometer available which can be used in comparative studies of traction with absolute accuracy. In all the instruments studied the necessity for determining maximum variations in results was evident. However, the hydraulic instruments yielded far better results than those working on the spring principle, and had the further advantage of indicating the average tractive effort directly.

REPORT ON HEAT INSULATORS BY THE ENGINEERING COMMITTEE OF THE FOOD INVESTIGATION BOARD [Great Britain Department of Scientific and Industrial Research, Food Investigation Board, Special Report No. 5(1921), pp. 61, figs. 16, published in London.] Studies of the thermal conductivity of the insulating materials commonly used in cold storage work are reported.

It was found that cork, slagwool, charcoal, and wood fibers, when of good quality and dry, have practically the same thermal conductivities, namely, 0.00011 gram calory per second per centimetre per one degree centigrade (0.32 B.t.u. per square foot per hour for one inch thickness and for one degree Fahrenheit difference in temperature). "Judging from the fact that such entirely different materials are about equally good as insulators, it would appear that their resistance to conduction is not very far from the limiting value that is practically obtainable by subdividing the air space. In this connection it is of interest to note that still air has a thermal conductivity of only 0.00005 C.G.S. units (0.14 B.t.u.'s per square foot per hour for one inch and for one degree Fahrenheit difference) or barely half that of the best of these materials, so there is still a margin for improvement by finding a more suitable material in cellular form."

Different brands of cork varied slightly in efficiency as insulators, but it is concluded that with samples of good quality such differences are not very considerable.

"It is clear that the thermal conductivity of materials in general such as cork is not an invariable physical constant like the thermal conductivity of pure metals. It follows that it is advisable to test samples of various consignments just as it is desirable to determine the calorific value of a fuel or any other commercial commodity. Materials that are liable to deteriorate in use decrease in efficiency as insulators in consequence of such change and the tests indicate that the decrease may be quite considerable. Coarse granular materials permit of the circulation of convection currents in the material which complicate the phenomenon of the heat transmission."

Supplementary studies of so-called cellular expanded rubber, consisting of rubber expanded by gas into a highly cellular form, showed that the conductivity of this material was lower than that of cork or any other substance studied, being only one and one-half times that of still air. The weight of the cellular rubber was only about half the weight of an equal volume of slab cork. The conductivity of spongy rubber was found to be greater than that of cork. Descriptions of experimental methods used are appended.

MEASURING AND MARKETING FARM TIMBER, W. R. Matton and W. B. Barrows [U. S. Dept. Agr., Farmers' Bulletin 1210(1921), pp. 62, figs. 20.] The purpose of this bulletin is to furnish information on the amount and value of standing timber and on the best means of marketing. Data are included on the different kinds and grades of timber products, the methods of estimating and measuring them and ascertaining their value, methods of selling, markets, and current market prices.

SEWAGE TREATMENT IN IMHOFF TANKS, R. Riker [Public Works, New York, 52 (1922), Nos. 3. pp. 39-42: 4, pp. 59-62: 5, pp. 89-91: 6, 106-107, figs. 7.] This report, a contribution from the Department of Health of New Jersey, summarizes experience with 37 Imhoff sewage tank installations in New Jersey serving 33 municipalities, 5 institutions, and 3 corporations. The widths of the tanks designed in the state range from 12 to 35 feet, the lengths from 30 to 70 feet, and the depths from 12 to 30 feet. Experience in the state does not indicate that the advantages in operation gained by building deep tanks warrant the increased cost of construction. It is agreed that the same bacteriological action occurs in both the one-story and two-story tanks. Grit chambers should be installed previous to tank treatment, but it is stated that no satisfactory grease trap for use at the plant is available. Pumping the sewage has somewhat the same effect on the suspended matter as fine screens.

It is concluded that the promiscuous installation of Imhoff tanks should cease, and that careful consideration of all factors should precede a decision to use Imhoff tanks for settling purposes.

IMPORTANCE OF GOOD AND WHOLESOME WATER FOR THE FARM, C. Zwagerman and L. W. Dewaardt [De Beteekenis van Goed en Voldoende Water voor het Boerenbedrijf. Goes: N. V. Waterleid. Maatsch. Zuid-Beveland, pp. 55, figs. 32.] This publication deals with water supplies for farms in the Netherlands, with particular reference to their sanitary aspects when used for drinking by man or animals, for cleaning purposes, and in butter and cheese making. Methods of storage and distribution of drinking water in dwellings, in stalls, and in pastures are discussed.

THE DETERMINATION OF DISTANCE BETWEEN DRAINS, E. Kruger [*Internationale Mitteilungen fur Bodenkunde*, published by F. Wunder, Berlin. 11(1921), No. 3-4, pp. 105-110.] Studies on the relative permeabilities of soils as influenced by their content of particles of less than 0.01 millimeter and of particles between 0.01 and 0.05 millimeter in diameter showed that the permeability increased as the content in coarser particles increased. This is considered to be a logical basis for the establishment of accurate methods for determining the proper distance between drains, the results being taken to indicate that the distance may be greater as the content of coarse matter increases. No exact relation is derived.

WORK UTILIZING TEAMS, M. Ringelmann [*Journal d' Agriculture Pratique*, Paris, n. ser., 35(1921), No. 49, pp. 472, 473, fig. 1.] The results of a study and analyses of the utilization of teams during a year on a French farm averaging 259.4 hectares (about 641 acres) are briefly reported.

The work stock consisted of 17 horses and 18 oxen. During the year it was found that there were 7,591.25 animal days of team work out of a possible total of 10,770.5 animal days, or a percentage utilization of 70.4. The highest utilization of animal days of team work was in March and October and the lowest in June and July. It was 87 per cent in March and 82 per cent in October. It is noted that 167 hectares were in clover, oats, beets, potatoes, carrots, and turnips.

TEST OF A TRACTOR OPERATING ON PRODUCER GAS, R. Greilsammer [Comptes Rendus des Seances de L'Academie D'Agriculture de France, Paris, 7(1921), No. 32, pp. 696-701.] A comparison of low-grade gas produced by the combustion of charcoal with gasoline as a tractor motor fuel in actual plowing is briefly reported, showing that the gasoline cost on this type of work in a 35 horse power four-cylinder motor was from six to seven times greater than the cost of the producer gas used. The gas produced about 25 per cent less power per unit than gasoline. More lubricating oil was required with the gas but the oil retained its lubricating properties a longer time. It is noted that valves, valve seats, and spark plugs were in better condition after using gas than after using gasoline. It is concluded that at present prices of charcoal an economy of about 85 per cent can be effected by the use of producer gas for tractor motors on plowing.

INVESTIGATION ON SOIL POLLUTION AND THE RELATION OF THE VARIOUS TYPES OF PRIVIES TO THE SPREAD OF INTESTINAL INFECTIONS, I. J. Kligler [Rockefeller Institute Medical Research Monograph, New York, No. 15 (1921), pp. 75, figs. 3.] Investigations are reported on the various types of privies in use, particularly with regard to the danger of soil polution and its relation to the spread of intestinal infections. Special attention was given to the pit and septic types of privy, although other varieties, particularly the pail and chemical closets, were also studied.

Repeated tests were conducted in the laboratory to determine (1) the viability of the typhoid and dysentery bacilli in soil and in increment under different conditions, (2) their ability to penetrate through columns of soil of different porosity, (3) their viability in septic fluids and effluents, and (4) the nature of the antagonistic factors in soil and septic material which influence the viability of these microorganisms. In the field work various types of privies of different ages were examined, particularly with regard to the extent of pollution of the soil surrounding these privies, their relation to well pollution, and the passage of material from the privies through the soil to adjoining wells.

It was found that the typhoid and dysentery bacilli succumb rapidly on exposure to an unnatural environment. Both typhoid and dysentery bacilli died out in from one to five days in septic tanks. In solid feces it is thought that the typhoid bacilli may survive for a period of from ten to fifteen days, while the dysentery bacilli were found to rarely survive longer than five days. The ara-typhoid bacilli were the most resistant members of the group and the Shiga dysentery bacillus was the most sensitive. The survival period of these organisms in soil was greater than in either feces or septic fluid and varied particularly with the moisture and reaction of the soil.

Temperature affected the viability, but the two main factors normally were moisture and reaction. In moist, natural soil, with a pH value of from 6.6 to 7.4, the typhoid and dysentery bacilli were recovered up to 70 days. In the same soil dry, the bacilli were not recovered after two weeks. In moist, acid soils, with a pH value of from 4.8 to 5.4, 90 per cent of the inoculated bacilli died out within the first 10 days. The others survived as long as 30 days. All the organisms survived longer near freezing temperature (4 degrees Centigrade) than at higher ones (20 to 37 degrees). The antagonistic action of soil bacteria on typhoid and dysentery bacilli was found to be due largely to the alkaline reaction resulting from their metabolism. Specific inhibitive substances were, however, elaborated by some soil bacteria, notably *Bacillus fluorescens and Bacillus proteus.*

The spread of pollution from a focal point was found to be limited in scope. Typhoid and dysentery bacilli under experimental conditions were not observed to spread laterally to any appreciable extent, although they were carried vertically through a column of two feet of porous soil. In denser soil they failed to penetrate through one foot. In the field where the subsoil was free from pollution, either near pit privies or near tile pipes from septic tanks, contamination extended downward to a depth of from three to five feet, and laterally only about three feet from the bottom of the pit or tiles. It is thought that heavy rains or constant dripping of water may carry surface pollution to a depth of ten feet.

Pollution of wells is concluded to be usually surface in origin. There was no correlation between the type or proximity of the privy to the degree of contamination of the adjacent wells. The purity of the well water varied rather with the condition of the well. Driven shallow wells with pumps were, as a rule, free from contamination, while dug wells with pumps or buckets were generally grossly polluted. Experiments with fluorescin failed to show subsoil pollution of wells from privies, but proved in some instances at least the possibility of surface contamination.

The general conclusion is drawn that in moderately compact clay, sand clay, or sandy soil free from cracks, the possibility of subsoil pollution of ground water is negligible, provided the ground water level is more than ten feet below the polluted area. "The pit privy can be used safely in any soil similar in character to those studied in the course of this investigation, provided the ground water level does not rise higher than ten to fifteen feet from the surface. In such soils a pit about three feet deep would be within the limits of safety if properly protected against flies. The cheapness and the relatively little care that it requires would recommend it in certain communities.

"In limestone regions and in soil where the water table is near the surface, the pit privy should not be considered safe. In such localities the Kentucky sanitary privy or one of similar design might be recommended. This type of privy should have a sufficient storage capacity to allow time for the destruction of pathogenic bacilli, approximately five days. If that precaution is taken there should be very little danger of infectious material passing from the drains to the ground water, especially if there is a layer of soil of about five feet between the drain and the ground water level. The drain pipe should also be placed about two feet below the surface.

"In general, it should be emphasized that any form of subsoil disposal should be designed with a knowledge of the character of the soil and particularly with due regard to the ground water level. The vertical distance between the source of pollution and the ground water is the significant factor. The horizontal distance between the source of pollution and the well is of relatively slight importance except when there are underground channels or cracks in the soil."

GULLIES: HOW TO CONTROL AND RECLAIM THEM, C. E. Ramser [United States Department Agriculture, Farmers' Bulletin 1234(1922), pp. 44, figs. 35.] The results of a study of the causes, types, results, and occurrence of gullies and of methods of prevention of gullying are presented in this bulletin. The more important methods of prevention discussed are plowing in and seeding, tiling and plowing in, tree planting, and the use of soil-saving dams.

Detailed information is given on the construction of loose straw, wooden stake, brush, woven wire, log, willow post, loose rock, stone masonry, concrete, and earth dams, on drop inlets for highway culverts and on outlets for soil-saving dams. Tabular data are also given showing cross sectional areas of pipe or conduit for drop inlet, soil-saving dams for rolling watersheds with length equal to about twice the width and showing distances between dams in gullies for dams of various heights and gullies of various bottom widths.

THE MODERN PACKING HOUSE, D. I. Davis [Chicago: Nickerson & Collins Co., 1921, second edition, revised and enlarged, pp. XVI+472, figs. 172.] This is a new, revised, amplified, and enlarged edition of this book, the first edition of which was prepared by F. W. Wilder. It is a complete treatise on the design, construction, equipment, and operation of meat-packing houses according to present American practice, including methods of converting by-products into commercial articles. It contains chapters on modern packing houses; location and construction; plant design; refrigeration equipment; refrigeration requirements; power plant requirement; coolers; warehouses; slaughtering cattle; dressing yields and cattle cutting; hides and pelts; oleo oil and stearine; bone department; tank house department; tank water; fertilizer; casings; beef miscellany; sheep and calves; hog slaughtering; pork cuttings; curing meats; lard, compound, and greases; smoke house; domestic sausage; dried sausage; butterine; boxes and cooperage; and departmental accounting.

INVESTIGATIONS ON THE ACTION OF SLOW SAND FILTRATION, W. Hilgers and L. Lauter [*Gesundheits-Ingenieur*, published by R. Oldenbourg, Munich and Berlin, 44(1921), No. 31, pp. 381-388.] Ten different series of studies on the factors influencing the purifying action of slow sand filters on water are reported. The influence of adding potassium cyanid on the protozoan content of filters was especially studied.

It was found that the temporary suppression of the filter action by potassium cyanid is not due to its toxic action on the protozoa but rather to the destruction of the film of colloidal organic matter on the surface of the filter.

It was found possible to form an artificial film such that a filtering action for bacteria took place, but such filters do not have normal action. It is concluded that the action of a slow sand filter depends primarily on the gelatinous organic matter which is separated mechanically from the filtered water but that filtration as a whole depends upon a series of factors, including depth and density of sand layers and organic matter content of the water, the activity of which involves colloidal phenomena.

THE COEFFICIENT OF ROUGHNESS IN CORRUGATED-IRON PIPE, D. L. Yarnell [*Engineering News-Record*, New York, 88(1922), No. 9, pp. 352, fig. 1.] In a contribution from the N. S. Dept., of Agriculture the results of 147 tests of 8 and 10-inch corrugated-iron pipe on nine grades ranging from 0.05 to 1.5 per cent to determine the coefficient of roughness n for Kutter's formula are reported. This coefficient was found to vary from 0.017 to 0.021 for pipe flowing full. There was a rather consistent variation in the value of n for the two sizes of pipe, for which no explanation is offered.

PALM OIL MOTORS AND BURNERS AND THEIR ACTUAL USE IN COLONIAL AGRICULTURE, G. Perpete [Annales de Gembloux, Brussels, 27(1921), No. 12, pp. 385-397, figs. 2.] Experience in the Belgian Congo on the operation of an internal-combustion engine and an oil burner using palm oil as fuel is described.

Tests with a 10-horsepower internal-combustion engine using an incandescent bulb for ignition indicated a minimum of carbonization and nearly perfect combustion. The palm oil was found to remain liquid in all parts of the fuel line, and a regular speed was maintained with a constant fuel charge. The consumption of lubricating oil apparently was exceptionally low.

SERVICE TESTS OF TREATED AND UNTREATED FENCE POSTS, J. D. Maclean. [American Wood Preservers Association Proceedings, 17(1921), pp. 401-424, fig. 1.] The results of a series of experiments conducted by the forest service, U. S. Department of Agriculture in cooperation with a number of the state agricultural experiment stations, on the durability of treated and untreated fence posts are reported. With a few exceptions the posts treated at the experiment station averaged from 5 to 6 inches in diameter and from 6.5 to 7.5 feet in length. Most of them were treated in the round form. A large proportion of the treated posts had been in service from ten to twelve years at the time of the last inspection.

It was found that the durability of the posts, whether treated or untreated, is influenced by a number of factors such as species, methods of seasoning, size of post, proportion of heartwood and sapwood, shape, and soil and climatic conditions.

Radial penetration was found to be of prime importance, and a good absorption was not always an indication of satisfactory treatment. Some species, such as basswood, bay, cottonwood, poplar, and willow appeared to take heavy absorptions due to end penetration but were very difficult to penetrate radially. This is taken to indicate the importance of securing the best possible radial penetration at the ground line and of the thorough treatment of both tops and butts, especially the tops of posts of nondurable species. The superiority of treatment of the entire post over butt treatment only was very marked. Butt treatments are apparently more suitable for posts of the durable woods in the split form or where they have very little sapwood. Brush treatment increased the life of the posts but was very inferior to the open tank method. Charring posts seemed to be of very little value as a protection against decay.

The order of merit of the nonpressure treatments employed, beginning with the most satisfactory method, was as follows: (1) Open tank treatment of the entire post in creosote oil, with butts treated in a hot bath followed by a cold oil bath for the entire post, (2) hot and cold bath butt treatment with coal-tar creosote, (3) cold oil bath only with coal-tar creosote, and (4) brush treatment with coal-tar creosote.

Water-gas tar apparently possesses preservative qualities, but the importance of selecting a water-gas tar of good quality is emphasized. Crude oil by itself seemed to be very unsatisfactory for post treatment on account of its low toxic value and the difficulty of obtaining a good penetration. The good results secured with the use of crude petroleum and with water- gas tar for the hot bath are taken to indicate the practicability of substituting a cheaper oil for the heating medium when creosote is employed for the subsequent cold bath.

The results of the experiments in various sections of the country showed that posts decay much more rapidly in the southern states than they do in the North. The open tank method of treatment seemed to be entirely satisfactory for fence posts, provided they were properly prepared and a suitable preservative used.

Analyses of several oils used in the experiments are included.

REPORT ON CLEANING CANALS WITH MODIFIED DISK HARROWS, MINIDOKA IRRIGATION PROJECT, IDAHO, H. L. Crawford. [Reclamation Record (U.S.), Washington, D.C., 13(1922), No. 2, pp. 22-24.] In experiments on the cleaning of irrigation canals of moss or so-called seaweed, it was found that submarine saws and scythes while effective were not feasible. A modified disk harrow was found not only to remove moss but to go down into the silt on the canal bottom and loosen a great part of the moss bulbs. It was found that only two cleanings were necessary for the season instead of one every two or three weeks with saws or scythes. A crew could clean on an average of one mile per day of main canal and 1.75 miles of lateral.

The essential difference between the modified disk and the ordinary farm disk harrow is in the steel frame which connects the disks to the drawbar. It consists of two 5/8-by-1¾-inch steel bars bent to form a semicircle three feet in diameter and placed one above the other at a distance of about four inches and rigidly bolted together at six points. A horizontal cross brace, consisting of a 1¾-by-3-by-¼-inch angle, joins the ends of the curved bars. A heavy tongue about eight feet long and shod with steel on both sides is fastened at one end to the center of the angle-iron cross brace. This tongue works between the curved bars and can be swung to several angles and bolted rigidly to the semicircular part of the frame. A heavy steel ring is fastened to the other end of the tongue, to which two ⅜-inch crucible steel cables twenty-five feet in length are attached for lateral work, or two fifty-foot cables on the main canals. The disk is operated by a team on each bank hitched to one of these cables. Twenty-inch disks are used on ⅞-inch steel shafts.

A. S. A. E. and Related Activities

A.S.A.E. Council Meeting in Chicago

THE Council of the Society held its second meeting of 1922 at the office of President Curtis, Chicago, June 13. The members of the Council present were President A. J. R. Curtis, Treasurer Frank P. Hanson, F. N. G. Kranich, George W. Iverson, and E. A. White.

The Council voted to publish one thousand copies of the 1920 A. S. A. E. Transactions. Work had already been well under way, so that the Transactions will be printed and mailed to the membership some time during the month of July.

In discussing the advisability of publishing original articles of permanent engineering value, that previously appeared in the Journal, in each volume of the Transactions, the Council passed a resolution that such original articles prepared either by members or non-members of the Society, which were prepared especially for the Journal, shall hereafter be published as a part of the Transactions. This will avoid the necessity of members keeping bound volumes of the Journal in order that all material of permanent engineering value may be filed, as this material will also be published in the Transactions, which are more convenient for reference purposes.

A motion was passed by the Council instructing the Secretary to get an estimate on the publication of one thousand copies of the 1921 Transactions and submit by letter ballot to the Council for decision as to publication during the latter part of the present year.

The amendment to paragraph C-35 of the Constitution offered at the last annual business meeting of the Society, providing that the time and place of the annual meeting shall be designated by the majority of members in attendance at the business session of the previous annual meeting, was discussed by the Council. The Council voted to lay the amendment of the table.

The Council discussed at considerable length the proposal to hold an agricultural engineering exposition in connection with the sixteenth annual meeting of the Society next December, and upon motion the Council decided to act as a committee to investigate the possibility of holding such an exposition and report on the matter at an early date.

Other matters, the most important of which were those of finances, membership, and publicity, were also discussed by the Council. The financial condition of the Society at the present time is favorable but whether or not the organization will come out at the end of the year without a deficit will depend principally on how well members in arrears for dues pay up between now and that time. It is very desirable that the Society close the year 1922 without a deficit.

Survey of Simplification Needs by A.E.S.C.

AT THE request of Secretary of Commerce Hebert Hoover, the American Engineering Standards Committee will undertake at once a canvass to determine what simplification in manufactured products is most needed and most desirable. This canvass will be conducted through the engineering and technical bodies having representatives on the Committee or cooperating in its work. The survey of simplification or standardization needs and possibilities will extend into almost every industry in America.

This assignment to the American Engineering Standards Committee is one of Secretary Hoover's steps to retrieve for American industry a few of the many billions of dollars wasted annually, as revealed in the report on waste in industry which was made not long ago by a committee also appointed by Mr. Hoover while he was president of the Federated American Engineering Societies. The latter committee found that waste in industry was due largely to an overmultiplicity in number of products as well as to inefficiency in process.

Of equal significance is the fact that Mr. Hoover's request that the American Engineering Standards Committee conduct this survey and the acceptance of the assignment by the Committee indicate a coordination of the work in the simplification of manufactured products, sponsored by Secretary Hoover, and the work of the American Engineering Standards Committee in the unification of standards on a national basis.

What should be the relationship between the simplification work of the Department of Commerce and the standardization work of the American Engineering Standards Committee has been the subject of considerable discussion. It is clear now that there will be no duplication or overlapping. There seems to be general recognition of the fact that simplification of product and improvement of process are to a large degree only other words for standardization: that they are standardization put to work. The joint movement for standardization and simplification may, therefore, be said to have begun its work in its own household by standardizing, simplifying, and unifying its own machinery and processes.

The executive committee of the A. E. S. C. has, by resolution, pledged the cooperation of the Committee to the Department of Commerce. Representatives of the Committee recently held a conference on the subject with Mr. Hoover at Washington. Subsequently an arrangement was made for permanent exchange of representatives between the two organizations so that there may be of the closest possible cooperation between the Commerce Department's division of simplified practice and the American Engineering Standards Committee.

Colors for Traffic Signals to be Standardized

A CONFERENCE on the standardization of colors for traffic signals was recently held in New York under the auspices of the American Engineering Standards Committee. There were present representatives of practically all of the big national engineering societies, safety associations, electric and steam railway interests, automobile dealers, manufacturers' and users' associations, police and traffic departments, insurance companies, and several departments of the federal government.

The conference agreed unanimously "that there should be national uniformity in the use of colors for signals" and that the detailed technical work involved in bringing about such uniformity should be carried out by a thoroughly representative sectional committee under the auspices and procedure of the American Engineering Standards Committee. Included in the scope of the work as defined were the following:

1. The use of colored lights on all highway vehicles.
2. Their use on all signals along highways and at curbs, both permanent and temporary.
3. Their use for highway crossing signals for steam and electric railways.

4. A coordinated relation of color, form, position and number of signals.

5. A coordinated relation to systems of flashing, moving or other similar lights.

6. Colors for nonluminous as distinguished from luminous signals.

7. Recommendations on the use of colors for emergency exit signals.

8. Methods of specifying or defining colors for signals purposes.

9. Any other closely related matters which, in the opinion of the sectional committee, form a part of the subject to be considered.

On the motion of Dr. M. G. Lloyd of the U. S. Bureau of Standards, a resolution was adopted declaring it to be the sense of the conference that any sectional committee of the A. E. S. C. which takes up the standardization of colors for signals should endeavor to coordinate such standardization with existing standards for traffic purposes, such as those used in water and aerial navigation and on steam and electric railways.

The conference did not advocate the substitution of green for red as a danger signal, as was erroneously reported in certain of the daily papers through a misinterpretation of discussion at the conference. On the contrary, the ideas expressed at the conference were emphatically that red should be used to indicate danger and for no other purpose. In conformity therewith, it was suggested that green be substituted for red as the color for lights for emergency exits of public buildings as indicating paths that lead to safety.

No final technical decisions were reached at the conference, these being left to be worked out in detail by a thoroughly representative sectional committee.

Cleaning Grain to a No-Dockage Basis

THE advantages of removing weed seed from grain at the time it is threshed have been generally recognized. Nearly all threshing machines have sieves to remove weed seeds which are smaller than the grain being threshed, but some device for removing wild oats, cockle, wild peas, and other weed seeds is of even greater benefit. During the past twenty years many attempts have been made to build a recleaner that would clean the grain to a no-dockage basis. The U. S. Department of Agriculture became interested in this work four years ago, and the experiments have developed one simple and practical recleaner for threshing machine use. A copy of the 1921 investigations along these lines will be sent on request to the department.

This year ten threshing machines are being equipped with recleaners for removing the dockage from wheat and rye at the time the grain is threshed. Eight of the recleaners are of the disk type, one is of the sieve type commonly used in foreign countries, and the other is an aspirator designed and built by the office of grain investigations of the U. S. Department of Agriculture at Portland, Oregon. This work is being carried on by the Department of Agriculture in cooperation with J. I. Case Threshing Machine Company, Advance-Rumely Company, Minneapolis Thresher Company, Nichols & Shepard Company, Port Huron Thresher Company, Carter-Mayhew Manufacturing Company, and the owners of the threshing machines on which the recleaners are being installed.

The location, size, and kind of separator, and the name of the owner of the thresher on which recleaners are being placed follow:

DISK TYPE RECLEANERS

Hastings, Minn. 3 miles N. W. 20x34 Port Huron, E. H. Chamberlain.

Farmington, Minn. 6 miles S. E. 36x58 Case, I. F. Hinz.

Fergus Falls, Minn. 26x46 Case, R. A. Gehrke.

Halsted, Minn. 4 miles S. W. 44x64 Red River Special, Jalmer Heere.

Michigan, N. D. 6 miles S. W. 40x64 Gaar-Scott, George E. Duis.

Milbank, S. D. 8 miles S. E. 28x48 Advance-Rumely, Louis Mielitz.

Spangle, Wash. 28x44 Advance-Rumely, George W. Carr.

Hopkins, Minn. 36x56 Minneapolis, Minneapolis Threshing Machine Company.

SIEVE TYPE RECLEANER (ADVANCE-RUMELY)

Pomeroy, Wash. 32x—Advance-Rumely separator, W. W. Richardson.

ASPIRATOR

Farmington, Wash. 27x—Case, E. J. Doneen.

The recleaners have been placed so that a wide range of harvest and threshing conditions will be met with, and as many different sizes and types of separators have been equipped as can be properly supervised. The investigational work in connection with these recleaners will be conducted for the U. S. Department of Agriculture in the State of Washington by E. N. Bates and George P. Bodnar; the other recleaners will be under the direction of E. G. Boerner, C. R. Haller, and R. H. Black. One of these men will probably be with each recleaner whenever the threshing outfit is in operation.

The grain cleaning division of the U. S. Department of Agriculture would like very much for as many farmers, engineers, and others interested to see one of these outfits in operation if possible. Individual opinions of the separation made by the recleaners and the value of the recleaners to custom threshermen and farmers will be appreciated by the department.

A leading figure in the effort of the U. S. Department of Agriculture to bring about the cleaning of grain to a no-dockage basis at the thresher is Robert H. Black, a member of this Society, in charge of the Minneapolis office of the grain cleaning investigations of the U. S. Department of Agriculture. It will be recalled that Mr. Black presented a paper entitled "Removing Dockage From Wheat at the Thresher" at the December 1921 annual meeting of this Society, which was published in the February 1922 number of AGRICULTURAL ENGINEERING.

Personal Items of Members

GUY H. HALL has been appointed director of the newly formed organization to be known as the National Institute of Progressive Farming, which will maintain headquarters in Chicago. Mr. Hall is well known to the tractor industry, being one of the pioneer tractor distributors. He was manager of the first five national tractor shows.

ELWOOD MEAD, recently elected honorary member of the Society, is at present in the Hawaiian Islands where he was called to advise with the Hawaiian Land Settlement Commission on land settlement problems. Dr. Mead is a pioneer in land settlement work and recognized authority on that subject. His work at the University of California is creating world-wide interest and recognition.

DAVID WEEKS has resigned as drainage engineer for the Dakota Engineering Company, Mitchell, South Dakota, to accept a position with the University of California. Mr. Weeks will be engaged in research work in the Division of Rural Institutions under the direction of Dr. Elwood Mead.

W. C. HOWELL was appointed head of the department of agricultural engineering at the Mississippi Agricultural and Mechanical College on June 10, to succeed E. R. Gross, resigned.

E. A. WHITE is special western editorial representative of Class Journal Company, publishers of *Automotive Industries, Motor World,* and *Motor Age.* Until recently he was technical editor of *Farm Implement News.*

E. R. WIGGINS has accepted a position with the Holt Manufacturing Company, Peoria, Illinois, and has resigned as technical editor of "Chilton Tractor Journal."

Wanted—Correct Addresses of These A. S. A. E. Members

NOTE: Mail is being returned from the addresses given below. These members, or others who know of their whereabouts, are requested to send the Secretary their correct addresses at once. Inasmuch as delivery cannot now be made, AGRICULTURAL ENGINEERING will not be mailed until correct addresses are received.

George J. Baker, 112 Theodore Street, Detroit, Michigan.

Claude S. Bristow, Elks Club, Portland, Oregon.

Leon P. Christensen, 375 S. First East, Logan, Utah

George Collins, 461 Market Street, San Francisco, California.

J. D. Eggleston, 1638 Iowa Street, Dubuque, Iowa

D. M. Emery, Illinois Hotel, Bloomington, Illinois.

F. K. Flynn, 1 Main Street, Watertown, Wisconsin.

K. D. Hequembourg, 531 W. 112th St., New York City.

W. C. Kreuger, North Carolina Agricultural College, Raleigh, North Carolina.

A. M. Leoni, 3832 Reisterstown Road, Baltimore, Maryland.

J. T. Montgomery, Alva, Oklahoma.

Arthur H. Pearsoll, 1350 Rosedale Avenue, Chicago, Illinois.

John Howard Rees, 2211 Commerce Building, Columbus, Ohio.

S. Y. Sweeney, 111 East Campbell Avenue, Roanoke, Virginia.

T. A. Toenjes, 1115 South Street, Waterloo, Iowa.

J. C. Weidrich, c/o Dempsey Hotel, Davenport, Iowa.

George G. Whitfield, Demopolis, Alabama.

New Members of the Society

MEMBERS

B. S. CLAYTON, drainage engineer, 310 Donaghey Building, Little Rock, Arkansas.

CLARK E. JACOBY, president, Clark E. Jacoby Engineering Company, Shukert Building, Kansas City, Missouri.

TRANSFER OF GRADE

ORMANN R. KEYSER, county agricultural agent, West Union, Ohio.
(From Student to Junior Member)

JAMES DEWEY LONG, 617 Northwestern Avenue, Ames, Iowa.
(From Student to Junior Member)

DARRELL B. LUCAS, Greene, Iowa.
(From Student to Junior Member)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to their election.

Don W. Griffin, Gwalior, Gwalior State, India.

Thomas F. McGilvray, consulting drainage engineer and county ditch inspector of St. Louis County, 503-504 Court House, Duluth, Minnesota.

1920 TRANSACTIONS

THE 1920 A.S.A.E. Transactions will be ready for distribution on or about August 1. Nonmembers should place their orders early as the supply is limited. Price to nonmembers $1.00; to members, 50 cents per copy.

EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER wants position as experimental agricultural engineer or with some agricultural publication. Graduate, 1918, agricultural college of the University of Illinois. Was editor of the Illinois agricultural students publication in his senior year. For two years employed by an explosives manufacturer as agricultural sales and service man for the State of Wisconsin. At present associated with the land clearing department of the University of Wisconsin. Age 25, married, American. MA-101

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915, five years practical experience on Illinois farm with power equipment, two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduate from the agricultural engineering course of the Iowa State College, who has had a great deal of experience in sewer work and farm building construction in the southern states, is interested in securing employment with a firm specializing on farm structures or farm sanitation. MA-107

AGRICULTURAL ENGINEER, graduate in agriculture at Cornell and trained in mechanical and electrical engineering, at present assistant professor of rural engineering at an agricultural college, wants position in the same or related field. Six years teaching experience and about six years engineering experience with telephones, milking machines, field machinery, concrete pipe making machinery and gas engines. Thoroughly trained in automotive theory and practice, including repair. MA-108

AGRICULTURAL ENGINEER wants position on a farm or with some firm where an engineering and general agricultural training is required. Will graduate from the agricultural college of the Ohio State University in June 1922. Major work done in agricultural engineering and farm management. Born and raised on farm. Age 22. Unmarried. MA-109.

AGRICULTURAL ENGINEER, graduate in mechanical engineering at Michigan Agricultural College, desires position teaching all kinds of farm machinery or automotive work, or with some farm-equipment manufacturer. Will be available April 1, 1922. Has served one year as instructor in tractors and trucks, and one year conducting service schools for a leading tractor manufacturer. Can furnish best of references. MA-110

AGRICULTURAL ENGINEER, graduate of Iowa State College 1920, with several years of practical experience farming with machinery and one year's teaching experience in high school, wants employment on a large farm or in college teaching of power farming. Twenty-five years of age. Married. MA-111

AGRICULTURAL ENGINEER, with eleven years' experience in agricultural engineering instructional and extension work, is available for position. Graduate of Agricultural College of University of Nebraska. Has had farm experience. Age 38. Married. MA-112.

AGRICULTURAL ENGINEER wants position as demonstrator of farm machinery or building equipment, or executive position on agricultural engineering project; or conducting field tests. Accustomed to handling men and dealing with farmers and farm problems. Prefers northern location. MA-113.